

BEYOND EINSTEIN: From the Big Bang to Black Holes

# Constellation

*The Constellation X-Ray Mission*



## **Science Enhancement Package (SEP) Status**

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## Science Enhancement Package

- RFI Solicitation specified :
  - “ SEP concepts should provide increased spectral resolution at low energies ( $< 0.6$  keV) to maintain a resolving power of  $R > 300$ , and/or additional throughput at high energies ( $> 10$  keV).”
  - Implementation of an SEP concept can not exceed 100 kg or \$100 M.
- Eight Responses were received covering a full range of options
- All SEP White Papers were presented at the Workshop yesterday
  - Specific SEP instrument configurations, performance predictions, and technical issues were presented and discussed.

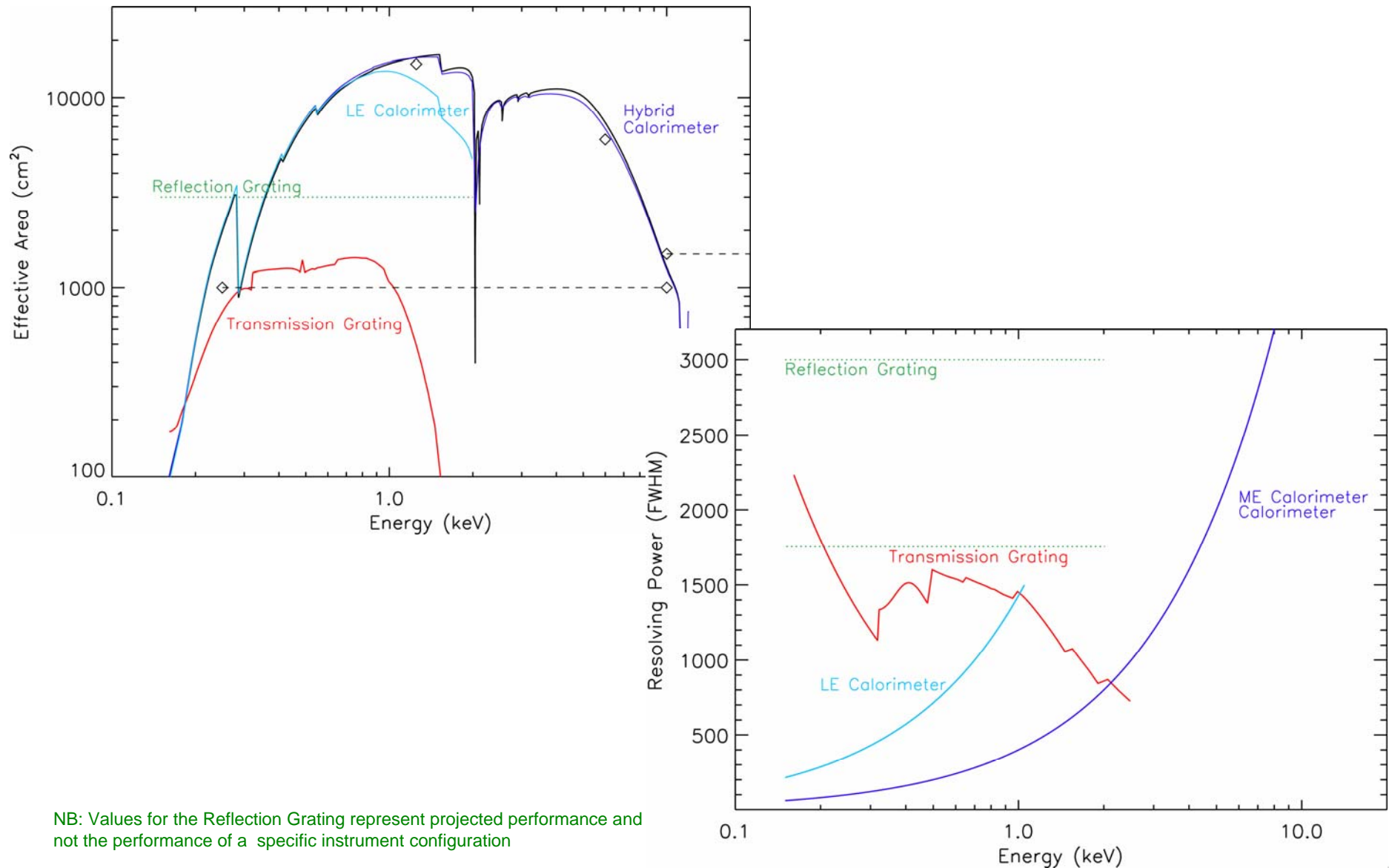
## Overview of SEP White Papers

Authors	SEP Concept	Mass Estimate
K. Flanagan et al.	Diffraction Gratings	60.6 kg
C. Lillie et al.	Diffraction Gratings	89 kg
R. Kelley et al.	Optimized Calorimeters	56 kg
M. Galeazzi et al.	Large Area Calorimeter	44% increase in XMS electronics & detector
P. Gorenstein & B. Ramsey	Hard X-ray Telescope	98.4 kg
J. Tueller et al.	Hard X-ray Telescope	55-60 kg for mirrors 19.5 kg detector
D. Windt	Multilayer SXT	---
K. Jahoda et al.	Polarimeter	14 kg

## Low Energy SEP Concepts

- SEP options for increased spectral resolution at low energies.
  - Diffraction Gratings
    - Movable off-plane reflection grating array located at  $1/3L$
    - Stationary transmission grating arrays
  - Optimized Calorimeters
    - Hybrid mid energy/low energy calorimeter array
    - Dedicated low energy arrays

## Low Energy SEP Estimated Performance



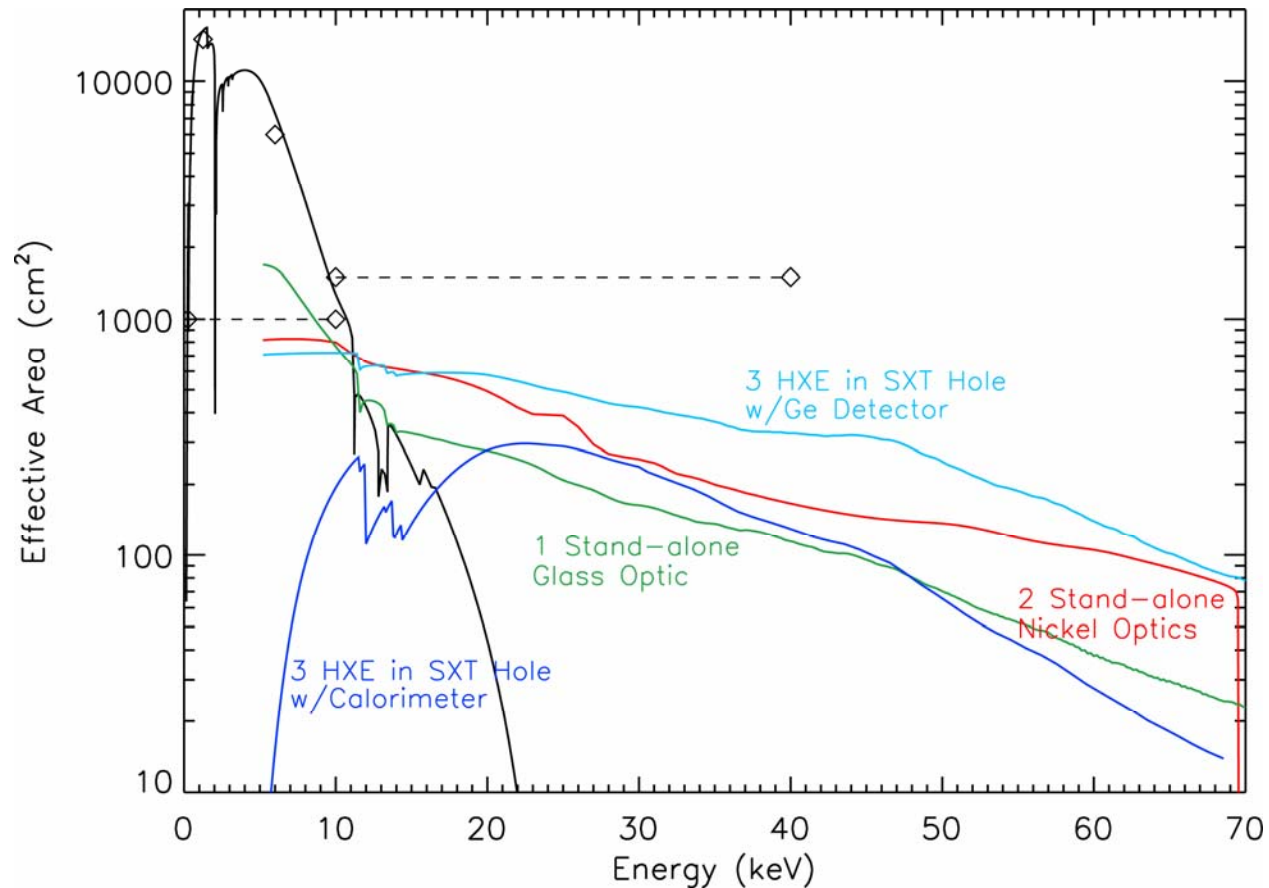
NB: Values for the Reflection Grating represent projected performance and not the performance of a specific instrument configuration

## High Energy SEP Concepts

- SEP Options for extending the high energy bandpass
  - Stand-alone hard x-ray telescope
  - Hard x-ray optic implemented at center of SXT with optimized high-energy calorimeters or Ge detectors
  - Add multilayer coatings to SXT optics with optimized high-energy calorimeters



## High Energy SEP Estimated Performance

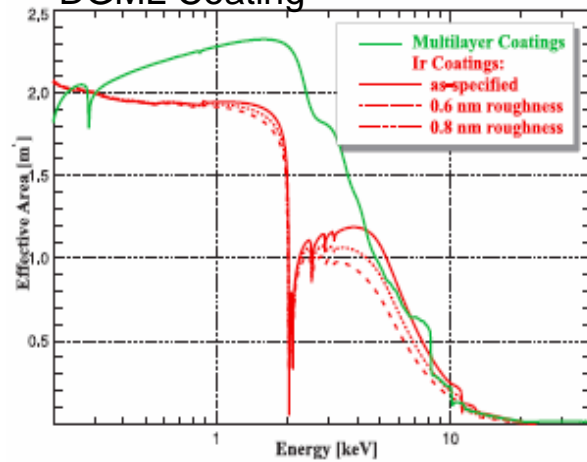


$\Delta E \sim 1 \text{ keV}$  for CdZnTe Detectors

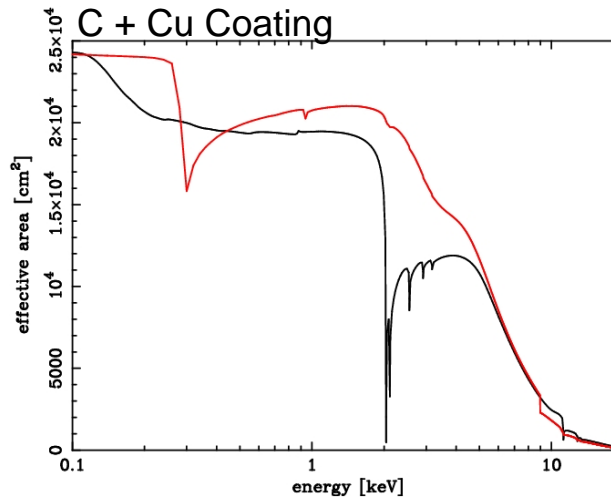
$\Delta E \sim 30 \text{ eV}$  for HE Calorimeters

## SXT FMA Coating

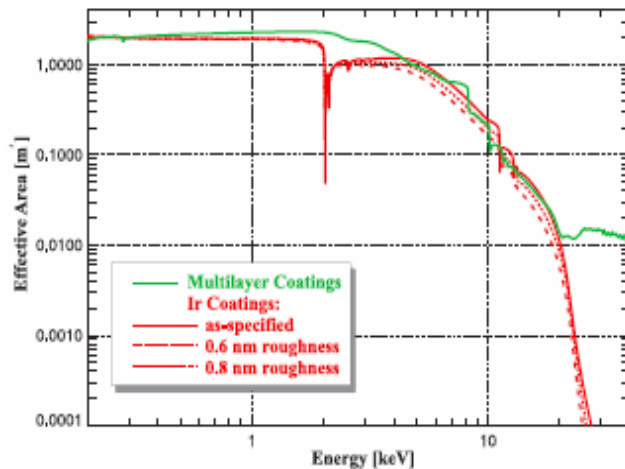
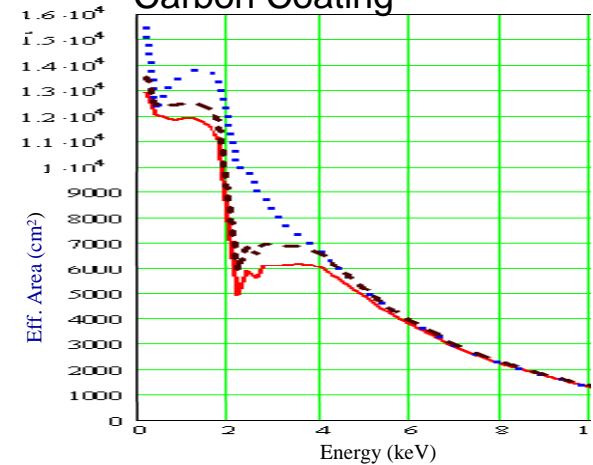
### DGML Coating



### C + Cu Coating



### Carbon Coating



- Multilayered SXT provides additional throughput at high energy that could be coupled with a high energy optimized calorimeter.
- All proposed SXT coating concepts, even a simple Carbon layer, provide additional throughput between 1 and 4 keV.



## Other SEP Concepts

- SEP options for improving the performance of the basic SXT and enhancing the science capabilities of the mission.
  - Low z coating on SXT mirror shells
    - To enhance effective area below 8 keV
  - Polarimeter
    - Measure polarization of X-ray fluxes

## FST Feedback

- The quoted SEP performance capabilities are only initial estimates.
  - Detailed science requirements must be defined before the SEP can be optimized.
  - The simulations that will be shown in the science talks use initial performance estimates, and might be considered the minimum achievable.
- Feedback from the FST during the science discussions is important in assessing the science enabled by the various SEP options, and in articulating the specific instrument capabilities that are needed.